# Floodplains in Zambia: The Scope for Shallow Well Development

16

Overview Paper Spate Irrigation

Spate Irrigation Network Foundation

## 1. Introduction

This paper looks at the potential of flood wells development in the floodplains of Zambia. It starts with an overview of the Zambian water resources (chapter 2), then it gives a detailed overview of the hydrological system, land use and agricultural production in the floodplains (chapter 3), analyses the geo-hydrological suitability of the floodplains for drilling (chapter 4), describe the stakeholders involved (chapter 5) and concludes with analyzing the feasibility of the floodplains to implement flood wells.

## 2. Water Resources of Zambia

Zambia's total renewable water resources are estimated at 163.4 $km^3$/yr. Water withdrawals for agriculture currently stand at 1.7 $km^3$/yr. Zambia has an irrigation potential of 2.75 Mha but only 156,000 ha are currently being irrigated (MACO/FAO 2004).

Deep groundwater is mostly abstracted through boreholes, while shallow groundwater is accessed through hand dug wells, scoop holes and springs. There is limited use of groundwater lifting devices in Zambia. Its applicability depends on the depth to the water source, availability of energy source, operation and maintenance cost of the equipment, the purpose/water use, and other socio-economic factors such as family income and size (Nonde 2012). These devices range from electrically motorized pumps to manual lifting devices to wind operated pumps. Furthermore ground water is generally of good quality but has hardly been exploited. The development of ground water resources has hitherto been poorly controlled or monitored.

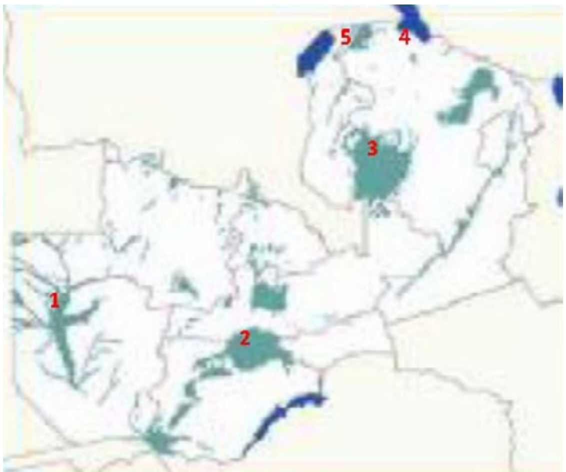


Figure 1: Location dambos / floodplains Source: AGWatersolutions 2012)

## 3. Floodplain Overview

In Zambia, floodplains and associated habitat include:

1) the Barotse Flood plain on the Upper Zambezi River in Western Province;
2) the Kafue Flats and Lukanga Swamp in the Kafue River Basin;
3) the Bangweulu swamps around Lake Bangweulu;
4) the Mweru Wantipa swamps;
5) Lake Mweru- Luapula Swamp in Luapula Province.

The wetlands are estimated to contribute around 5% of gross domestic product (GDP). They often support the poorest people in a region, so their economic benefits are often more significant than a simple measure of their contribution to GDP might imply (IWMI 2014).

| Sub-Basin | Length in Zambia (in km) | Basin area in $km^2$ | | | % contribution to surface | Annual runoff ($km^3$) |
|---|---|---|---|---|---|---|
| | | Total | in Zambia | Outside Zambia | | |
| Zambezi | 1,700 | 687,089 | 268,235 | 418,814 | 36.36 | 41.75 |
| Kafue | 1,300 | 156,995 | 156,995 | - | 8.40 | 9.88 |
| Luangwa | 850 | 147,622 | 144,358 | 3,264 | 19.44 | 22.32 |
| Chambeshi | 560 | 44,427 | 44,427 | - | 7.62 | 8.75 |
| Luapula | 615 | 173,396 | 113,323 | 60,073 | 26.25 | 30.14 |
| Lake Tanganyika | 250 | 249 | 15,586 | 233,144 | 1.73 | 1.99 |
| **Total** | **5,272** | **1,458,489** | **743,194** | **715,295** | **99.8** | **114.83** |

Table 1: Water Basins Zambia (Source: JICA-MEWD, 1995)

## 3.1 Barotse Floodplain

The Barotse Floodplain is situated on the upper course of the Zambezi river and includes a wetland of 9,000 km$^2$ in the Western Province. The floodplains lie on Kalahari sands and the river bottom is predominantly composed of shifting sand. The key factors affecting utilization of the wetland are the timing and extent of the annual flooding of the Zambezi River, and the timing and consistency of the rains.

The peak of the flood occurs on the floodplain about 3 months after the peak of the rainy season (up to 1500 mm of rain falls over the headwater catchments of the Zambezi each year) in January–February. The flood usually peaks in April, and recedes in May to July, when grasses quickly grow on the exposed plain. At the river's lowest water in November the floodplain still contains about 537 km$^2$ of lagoons, swamps and channels.

The flood leaves behind a fertile grey to black soil overlaying the Kalahari sands, enriched by silt deposited by the flood as well as humus from vegetation killed by the initial flood, and from decaying aquatic plants left to dry out in the mud.


Figure 2: NASA satellite photograph showing the Barotse Floodplain as the bright green to dark blue central region.

It provides a good soil, but in the late dry season it bakes hard in the heat of the sun. As the floods recede, water is left behind in lagoons, swamps, and oxbow lakes (Emerton 2003).

The central part of the Barotse Floodplain is inundated to a depth of 1.5-3 m when the flood peaks in April. The flood recedes over a six month period from May until October, but by September most of the floodplain is dry, and water is restricted to lagoons connected to the river by backwater channels, and to numerous isolated lakes. At this time the main channel is some 25-50 m wide and 3-6 m deep (Emerton 2003).

Most of the population in the Barotse floodplain depend on a mixed livelihood strategy, combining crop farming, livestock keeping, fishing and natural resource exploitation. This diversity of livelihood components, many of which depend on wetlands, is an effective strategy for spreading risk, and income and subsistence sources vary at different times, especially according to season.

Floodplain farming systems are diverse, and include raised gardens (Lizulu), rain-fed village gardens (Litongo), seepage gardens (wet Litongo), drained seepage gardens (Sishango), lagoon gardens (Sitapa) and riverbank gardens (Litunda). (Emerton 2003).

Cropping is undertaken in line with this natural rain pattern. The main growing season is between November and April. Various crops including maize, sorghum, pumpkin, mango, rice, cashew and vegetables are cultivated, and cattle are also kept. 28,000 ha of cultivation supports approximately 27,500 households and is estimated to be worth $2.34 million. In the same area, 265,000 head of cattle that graze on the floodplain are valued at approximately $3 million. Furthermore reeds and papyrus collected from the Barotse floodplain wetland in Zambia are estimated to have a value to local communities of $373,000 y$^{-1}$ (Emerton 2005).

## 3.2 The Kafue Flats

The Kafue Flats is the second biggest floodplain in Zambia after the Barotse floodplains, extending for about 353 km long and covering an area of 6 500 km$^2$, comprising the Kafue main river channel, lagoons and swampy areas. For most of this river reach, the Kafue meanders through a large flat grassland floodplain, with a minimum elevation of 1,065 meters and the height difference between Itezhi-tezhi dam and Kafue Gorge being only 15 m over a distance of 353 km.

| Season | Months | Flooding Pattern |
|---|---|---|
| Start of rainy season | January-February | First minor flooding of the Zambezi river after the rains in January-February. |
| End of rainy season and major floods | April | Floodplain is inundated to a depth of 1.5-3 m when the flood peaks in April. |
| Retreat of water / early dry season | May to July | Grasses quickly grow on the exposed plain. |
| Dry season | August to December | Floodwaters recede slowly from the Barotse Plain during the six-month dry season. By September most of the floodplain is dry, and water is restricted to lagoons connected to the river by backwater channels, and to numerous isolated lakes. |

Table 2: The flooding cycle of the Barotse floodplain

The main lagoons are Chansi, Chunuka, Luwato, Namatanga, Namwala and Lukwato. Evaporation losses over this area are considerable with annual pan-evaporation being estimated as 2,203 mm. The Kafue Flats area is said to act as a natural reservoir with a natural outlet at Nyimba, which is about midway from Itezhi-tezhi to Kafue Gorge.

The hydrological pattern in the Kafue Flats is very unusual: Annual rainfall is about twice as much in the northern part of the Kafue Basin than in the Kafue Flats itself, and the major tributaries reach the Kafue in the upper part of Kafue Hook. This implies that about 80% of the total rainfall in the basin passes Itezhithezhi. Downstream capacity is quite low, so large areas get flooded. There are two swamp areas (Luakanga and Busanga) in the upper part of the Basin. The latter acts as a water storage system because the outflow to the Kafue is slow and the majority of the water is lost by evaporation The annual flooding in the Kafue Flats itself is determined largely by these inflows from the northern part of the Basin, regulated by the swampy areas. Local rainfall and efflux is limited. The major reason for inundation and flooding is a high level of efflux at Itezhitezhi. The Kafue channel has a limited capacity of about 170 m3/sec$^{-1}$.

In the peak season the inflow in the Kafue River, with a normal peak of 1410 m$^3$/sec$^{-1}$, exceeds this capacity by 7 or 8 times. This then results in large inundations The most important aspect of the floodplain is its flooding cycle, which is presented here in a four-stage pattern (Haller 2007)

The Kafue Basin has commercial, medium, small scale and peasant farmers. Commercial farmers are mainly concentrated along the line of rail and major roads. They are involved in cash crops and livestock production. Cash crops include maize, wheat, potatoes, flowers and herbs. Intensive irrigation methods are used for cash crop production. Livestock rearing is for dairy, chicken and beef production (APFM 2007). In the Kafue Flats, 250,000 head of cattle graze during the dry season each year. The market value of these cattle is estimated to be \$4 My$^{-1}$ (Seyam et al. 2001).

### 3.3 Lukanga and Bangweulu swamps

The Lukanga swamp is located approximately 50 km west of the city of Kabwe, in the Central province of Zambia, within the catchment of the Kafue River. The swamp occupies a shallow depression covering an area of approximately 2,590 km$^2$. The swamp is shallow with depth not

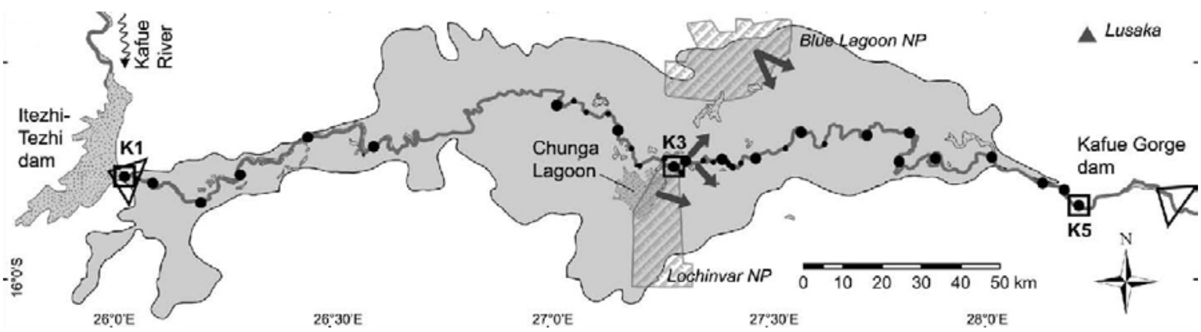


Figure 3: Kafue flats (source Zurbrügg et al. 2012)

| Season | Months | Flooding Pattern |
|---|---|---|
| Start of rainy season | November to January | Minor flooding from local rains and tributaries, towards end main river and tributaries are connected |
| End of rainy season and major floods | February to April / May | Little local rainfall but massive discharge of water from the Kafue. Whole floodplain is inundated (3.000 – 5.000 km$^2$) |
| Retreat of water / early dry season | May to July | River level falls again, water retreats but there are many pools and oxbows as well as lagoons |
| Dry season | August to October | Water has completely retreated, some permanent ponds and lagoons as well as oxbows remain, area is dry, strong winds. |

Table 3 : The flooding cycle of the Kafue Flats ( Source: Haller 2007)

exceeding 6.1 m, even at the height of the wet season. The area of permanent swamp and open water is approximately 2,100 km$^2$ (McCartney, 2007).

The Lukanga wetland comprises three characteristics types: palustrine, lacustrine and riverine. The palustrine wetland covers approximately 95% of the area and includes permanent swamp, termitaria grasslands and dambos. The lacustrine wetlands cover about 5% of the wetland. The riverine wetlands occur along the fringes of the Lukanga and Mushingashi rivers

Water in the swamp comes from three sources: direct rainfall into the swamp, inflow from tributary streams and spill from the Kafue River. The catchment area of the swamps is approximately 14,245 km$^2$ with the main inflowing river being the Lukanga river, which originates to the north of the wetland in the Zambian Copper Belt (McCartney, 2007).

It is estimated that about 60,000 people live in, or close to, the wetland and that products, derived from fishing, hunting, and agriculture. Most settlements are located around the edge of the wetland, though some fishing camps are situated on the larger islands located within it (Chilwa Island and Maunga Island).

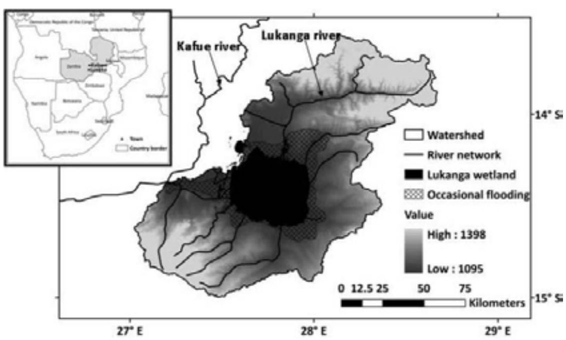


Figure 4: Lukanga catchment area (Source McCartney et al 2011)

Fish are an important source of cheap protein for local households and also provide income for fishermen who sell a proportion of their catch in Kabwe and other towns in Central Province and the Copper Belt, as well as Lusaka. One constraint to fish production is the difficulty of transporting ice into the wetland for preserving the catch before it can be transported to market. Across the wetland, the annual fish catch (primarily tilapia, barbel, bream, and catfish) is estimated to average 1,710 tons. This indicates an annual production of at least 15 kg ha$^{-1}$ (McCartney 2011).

Agricultural production systems are generally poor with most smallholders farming close to subsistence level. There is little irrigation, but recession agriculture is practiced, with many plots located around the edge of the wetland. The main crop grown is maize. Other crops include cotton, groundnuts, pumpkins, sweet potatoes, cassava, and sunflowers.The wetland also provides dry season grazing and watering for herds of cattle and goats. Other products from the wetland utilized by local communities, include fibers (i.e., grass, leaves, vines, and papyrus) used for construction materials and for making mats, baskets, and poles for punting canoes in shallow water (McCartney 2011).

The Bangweulu floodplains and perennial swamps is located in Luapula Province in Northern Zambia. Samfya, on the western shore of the lake is the biggest town and the executive centre of the Samfya district. The great swamp which stretches widely to the south and south-east of Lake Bangweulu is about 5.000 km$^2$ in extent at the end of the rainy season. The Bangweuleu swamps can be characterized as a vast, shallow, oligotrophic (nutrient deficient), seasonally fluctuating, but overall predictable aquatic system.

The main inflow is via the Chambeshi River that enters the swamps from the east. The surplus water leaves the Bangweulu swamps in its south-western part through the Luapula River, which later enters the Lake Mweru further north and subsequently connects with the Congo River system (Kolding 2011). The fishery is among the most important economic activities in the area, and contributes 20% of the total Zambian fish production (15.000 tons of fish annually) (Kolding 2011). Cultivation (dambos) and settlements can be found on the fringes of the floodplains.

### 3.4 The Northern Dambos

Northern Upper Plateau comprises dambos, which are grassland areas that seasonally flood or have high water tables. During and for some time after the rainy season, the dambos are waterlogged or flooded, but during the later part of the dry season most of them dry out at the surface. They are particularly prevalent on level or gently undulating surfaces but are found in a range of forms and position in the landscape. Sour dambos are common in the northern half of the country which receives heavier rainfall.

Soil pH in these dambos is below 5.5. The benefits from dambos, include domestic water supply, grass for thatching, wild plants, grazing, dry-season. Supplementary cultivation and planting of perennial crops. A wide range of crops can be grown in up to three crops per year, including vegetables, maize, rice, bean and sweet potato. On average, 70% of households in the region are reported to have a dambo or wetland field averaging 0.2-1.25 ha (AgWater Solutions Project 2009).

Water management is usually by the use of simple drainage channels or planting on high ridges to avoid water logging but use the residual moisture (capillary action) and planting of crops with tolerance to water logging conditions.

## 4. Hydro-geological suitability for drilling

The country's aquifers are classified into three main types, namely, (i) aquifers, where groundwater flow is mainly through fissures / channels / discontinuities, which are classified as either highly or locally productive; (ii) aquifers, where intergranular groundwater flow is dominant, which occur mainly in alluvial soils; and (iii) Low yielding aquifers with limited potential. (JICA, MEWD 1995)

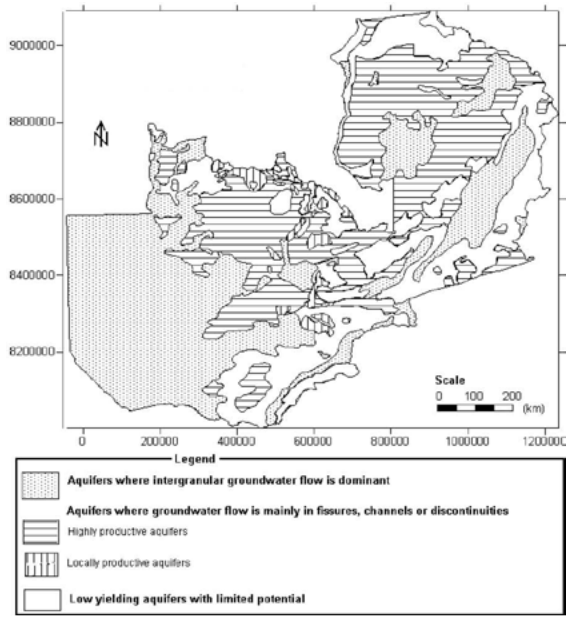


Figure 5: Geo-hydrological map (source: JICA-MEWD. 1995)

**Aquifers Where Groundwater Flow is Mainly in Fissures, Channels and Discontinuities**

Groundwater occurs in secondary rock features and structures such as weathered zones, faults, joints, fractures and solution features that usually extend to around 30 m to 40 m in depth within consolidated hard rocks. They may occasionally extend to more than 90m in depth. Such aquifers may be subdivided into two, namely:

- Highly productive aquifers: These include Upper Roan Dolomite and Kundelungu Limestone (1-70 l $s^{-1}$), but have limited and very narrow area of distribution. Some large cities such as Ndola and so on are located on such aquifers.
- Locally productive aquifers: The Lower Roan Quartzite, Muva sediments, granites and undifferentiated Kundelungu Formations (0.1-10 l $s^{-1}$).

**Aquifers Where Intergranular Groundwater Flow is Dominant**

These are found in the Alluvial Formation, Kalahari Group and Karoo Group. These aquifers are distributed mainly in the Western, Southern and Eastern parts of Zambia. They are also distributed around Chambeshi River and Lake Bangweulu (0.1 – 15 l s-$^{1}$).

**Low Yielding Aquifers with Limited Potential**

These aquifers are mainly distributed in Eastern and Southern parts of Zambia (0-2 l s-$^{1}$). They include the major part of Argillaceous Formation, Karoo basalts and older Basement Complex.

Generally borehole drilling in Zambia is relatively shallow, to a depth of 60 m on average, and certainly less than 100 m with aquifers between 24 m to 85 m. Drilling is mostly undertaken for potable water extraction by hand-pumps, which is the pre-dominant demand to serve the needs of the rural population. It is observed that drill rigs presently active in Zambia are generally heavier than are normally required for hand-pump boreholes, in that they are suited to drill larger diameters to several hundred meters (Armstrong 2009).

Some 30% of the land area of Zambia, particularly in the Western Province, has very fine grain “Kalahari Sands” which are particularly difficult to drill and then case, and are usually combined with poor accessibility. Drilling in these areas using conventional methods needs a high degree of skill and is relatively costly. It is perceived that numerous boreholes have failed in the Kalahari Sands of the Western Province due to improper well design. Historically drilling in these areas has involved large diameter, mud-circulation drilling. Large diameters are specified to assure the gravel packs nicely around the screen casing without bridging (Armstrong 2009).

Manual drilling techniques however are much more convenient in those areas, as no heavy equipment is needed and costs are at 2-4 times lower. Specifically the jetting technology, which makes use of water and polymers that circulate and keep the borehole open, has proven to be a successful method in Western province. This is illustrated by figure 6, which indicates that the “Kalahari Sands” area correspond to a very high suitability for manual drilling. This classification is based on two essential requirements for manual drilling, i.e. the absence of hard layers (rock, consolidated layers) that cannot be penetrated and the presence of permeable layers (sand, gravel) that could work as an aquifer. Suitable areas therefore correspond to the intergranular aquifers shown in figure 5. Aquifers in fissures, channels and discontinuities could provide very large water yields, however these are situations between and within hard layers that cannot be drilled manually.

Next to the geology, the presence of shallow groundwater tables is crucial for the feasibility of manually drilled boreholes. This is because the maximum depth to drill manually is limited to 30-50 m. In figure 7, the geological suitability map is combined with water depth data of 8.569 water points, to indicate the overall technical feasibility for manual drilling. Areas classified as highly suitable and suitable have a static water level of less than 10 m, and 10-25 m respectively.

## 5. Stakeholders

### 5.1 Government

The Technical Services Branch (TSB) in the Department of Field Services of the Ministry of Agriculture and Cooperatives (MACO) is the main institution mandated to plan and develop all aspects related to irrigation and water management. The TSB consists of three sections, namely: i) Irrigation Engineering Section; ii) Land Husbandry Section; iii) Farm Power and Machinery Section. The TSB through the Irrigation Engineering Section provides services to farming enterprises in irrigation agronomy, catchment hydrology and related hydraulic and civil engineering aspects. It also helps the Government to formulate policies for irrigation development, to carry out water resources assessments and to implement irrigation projects.

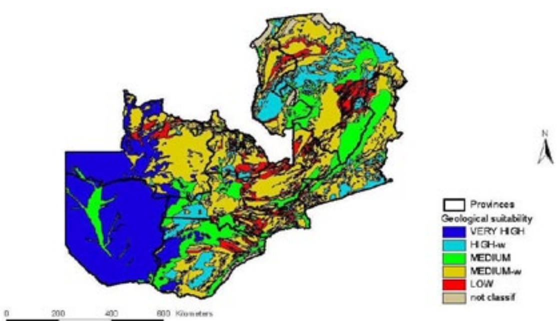


Figure 6: Geological suitability for manual drilling (source: UNICEF, 2011)

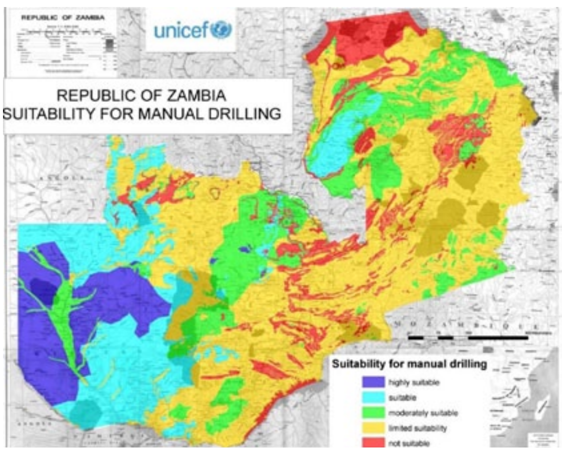


Figure 7: Suitability for manual drilling (source: UNICEF, 2011)

While many other government agencies with interest in the irrigation sector exist, the Ministry of Energy and Water Development (MEWD) is the key one. It houses the Department of Water Affairs (DWA) and the Water Development Board of Zambia, both of which are mandated to deal with water resources development and management. The Water Development Board of Zambia allocates water rights although no water charges have been levied on any irrigation abstractions. All land allocations for any development purposes, including irrigation, are the responsibility of the Ministry of Lands (MOL), which is also responsible for issuing title deeds. Its current policy is to set aside at least 30 % of the demarcated land for women and other vulnerable groups.

Department of Water Affairs owns over 30 sets of drilling equipment, including rigs recently received from JICA. DWA drills throughout the country, including for private clients. DWA charges $3,000 to $3,500 to drill 100m in the capital, but the equipment costs have been undervalued; a sum of $500 goes to DWA for the equipment. As this is below market rates, DWA private drilling is effectively subsidised. Boreholes that are drilled by private operators with machine rigs in Western province can go up as high as 6-7,000 USD.

DWA also maintains paper files for siting and drilling operations. Data from 1970 onwards are present in the files. The database stores information on over 3,000 water points including hand dug wells, boreholes, springs and unsuccessful groundwater exploration drill sites. The database includes the information of all the major hydrogeological investigations carried out since the mid-1970s and combines general information with comprehensive and detailed technical information on groundwater hydraulics, borehole design, geology and groundwater quality. Data has been grouped into four categories, namely groundwater quality (779 water points); groundwater hydraulics (697 water points), lithological description (519 boreholes); and groundwater point information encompassing 3,116 water points, 1,620 drilled boreholes, 1,150 hand dug wells, 13 thermal springs and 159 reported unsuccessful boreholes.

The Ministry of Local Housing and Development (MLHD), UNICEF and PRACTICA are currently working on the professionalization of manual well drilling. Twelve enterprises have been trained and each of them will get ownership of a basic jetting kit with a value of 3,000 USD. Within the programme 120 Wells have been drilled manually, with an average cost of 2,500 each including pump. These are communal high quality wells. The price of flood wells for irrigation will be much lower since no hygiene precautions are required, different pumps are used and depths are limited. Such flood wells would be below 500 USD. Therefore the manual drilling sector that is currently being developed could serve smallholder farmers as well.

## 5.2 NGOs

Organizations supporting manual well drilling programs in Zambia include UNICEF; PRACTICA Foundation, the Netherlands; Development Aid from People to People in Zambia (DAPP), Zambia. Furthermore there are NGOs part of the NGO WASH forum that also have borehole / manual well drilling as one of their activities (see Appendix 1).

## 5.3 Private sector

Drilling enterprises need to be registered at the NCC agency (government entity providing licenses to enterprises). However currently manual drilling enterprises are not able to register at NCC and not apply to government tenders. This is because NCC only "knows" machine drilling business and they require for registration for example the ownership of a big drilling rig and qualified personnel.

Furthermore there is a price-war on drilling taking place in Zambia which has led to some local contractors not able to compete with international firms, and thus go out of business. There are also a range of practices, some of which are particularly unscrupulous in order to make profit. The low prices are one of the drivers of this problem. A general lack of trust of consultants is also an issue in Zambia (Danert & Furey 2012) The UNICEF experiences of the One Million Initiative in Zambia have illustrated the advantages of revising contractual procedures and technical specifications of drilling programmes, not only to reduce costs but to improve cost-effectiveness. The following are the main lessons learned from these two experiences:

- Drilling companies offer better unit prices when boreholes are geographically clustered in contracts.
- Small drilling companies can benefit from clustered contracts through the enabling of simple approaches such as forming consortia.
- Mobilization and demobilization costs are reduced when packages of boreholes are contracted.

# 6. Feasibility analysis for implementation flood wells

## 6.1 Barotse plain

From a hydro-geological point of view manual drilling in the Barotse plain is characterized as moderately suitable, since the area can be easily drilled but there are changes of finding clay and silt formations at shallow depths besides areas with a lot of sandy formations. Detailed assessments or deeper wells are necessary in this case. Field observations indicate that some irrigation takes place near Mongu, but that the main part of the floodplain is not cultivated during the dry season due to the nature of socio-economic activities. Most people along the Zambezi practice fishing as source of food and income. Irrigated spots concentrate near depressions where surface water is found throughout the year.

In the remainder of the plain the water table remains extremely shallow during the dry season, observations done ranging from 0.1 -1 m depth. Hence, water access by hand digging is very easy and costs are extremely limited. Due to the sandy terrain, collapsing of wells is a frequent problem, which could be solved by the introduction of flood wells. However, drilling costs will need to be extremely low to convince farmers to pay for a borehole when the groundwater is found at such a shallow depth. Rapid well jetting could be an option to explore as its costs are very low.

Agriculture in the Barotse plain is vulnerable to drought. Within the plain, there is many scattered shallow circular pans varying from <1 km to 5 km in circumference. A number of these are connected by natural spillway channels and some artificial canals. The area is also characterized by scattered zones of perched water tables that are used for winter cropping, utilizing subsurface soil moisture.

An opportunity exists to utilize the plain outside the rainy season through low-cost water-lifting and application technologies.

## 6.2 Kafue plain

Unlike the other floodplains and wetlands described above, the Kafue plain is not characterized by intergranular alluvial soils only. It is featured by a rather heterogeneous geology with differing aptitudes for manual well drilling. Next to the moderately suitable riverine plains the area includes a number of lagoons, and adjacent areas are generally characterized by lacustrine sediments consisting of thick impermeable clay layers. Hence, the feasibility for manual drilling is very variable, and local geographical knowledge is essential for the identification of suitable areas. The Kafue plain is almost as heterogeneous from a socio-economic point of view and figure 8 indicates a medium-low to medium-high demand for water lifting technologies. The variable character of this floodplain requires a thorough assessment of potential support measures rather than the promotion of a particular technology package such as flood wells.

## 6.3 Lukanga and Bangweulu swamps

The technical feasibility for manual drilling in the Lukanga and Bangweulu swamps has been classified as limited, since the areas are featured by static water on thick impermeable soil layers. This impedes groundwater abstraction and results in boreholes with low water yields. Field observations and expert consultation on the potential for tube wells in the Bangweulu swamps indicated that these areas are mainly used for fishing and that the demand for tube wells would be very limited. However, an integrated fishing and flood based farming approach could be promoted. Examples include rice production or irrigating higher situated vegetable fields with low-cost pumps to make use of the abundant surface water in the area.

## 6.4 Northern dambos

Geologically the feasibility for manual drilling in the Northern province dambos has been evaluated as medium, with similar soil conditions as found in the Barotse floodplain. Figure 8 shows that socio-economically, the scope for flood wells and/or low-cost pumps is more promising than in Barotse, since high population densities and more market-oriented smallholder farmers create a larger demand for water extraction technologies (FAO, 2012).

## 6.5 Potential for follow-up project

The technical and socio-economic suitability of flood wells for the different regions is summarized in table 4. Furthermore the potential for a follow-up flood well project is given.

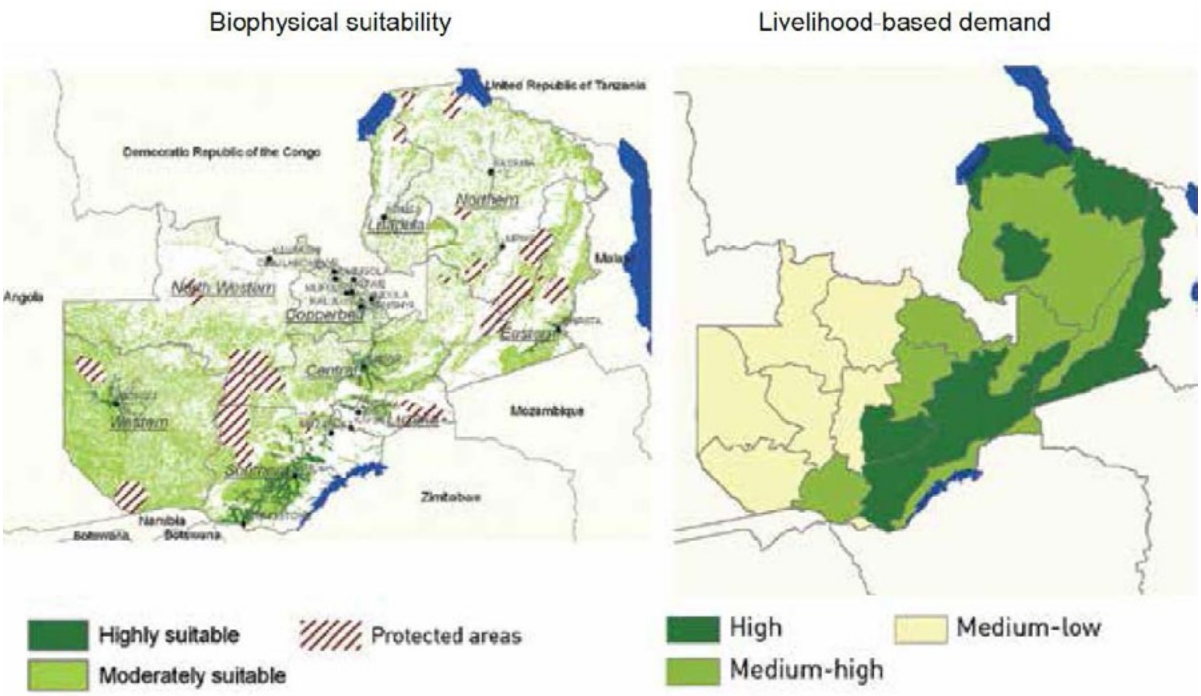


Figure 8: Potential for small motor pump use (Source: FAO 2012)

| Member | Activity | Provinces | Contact Person | Email Addres |
|---|---|---|---|---|
| Africare | Capacity Builling, Hygiene Education and Hygiene Promotion | Southern, Luapula | Liberty Habeenzu | lhabeenzu@africare.org.zm |
| Care International Zambia | IEC,Capacity Building, Hygiene Education and Hygiene Promotion | Eastern | Cathryn Mwanamwambwa | mwanamwambwa@carezam.org |
| Child Fund Zambia | Sewerage and Waste Water, Bore hole drilling, Capacity Building, Advocacy | Lusaka | Lydia Jumbe | ljumbe@zambia.childfund.org |
| OXFAM GB | Advocacy, Borehole Drilling, Capacity Building, Advocacy | Western, Lusaka | Luckson Katsi | lkatsi@oxfam.org.uk |
| SFH | IEC, Capacity Building,, Hygiene promotion and Education. | | Charles Kalonga | charlesk@sfh.org.zm |
| Water Aid in Zambia | Advocacy, Borehole Drilling, Capacity Building, Hygiene Education, Hygiene Promotion, IEC, Renewable Energy, Sewerage and Waste Water | Southern, Western, Luapula | Mundia Matongo | mundiamatongo@wateraid.org |
| SEEDS Of Hope International | Borehole drilling, Hygiene Education and Hygiene promotion | Copperbelt, Lusaka | Evan Chiyengi | echiyenge@yahoo.com |
| Norwegian Church Aid | Advocacy, Borehole Drilling, Capacity Building, Hygiene Education and Hygiene Promotion. | North Western | Alick Mwale | alick.mwale@yahoo.com |
| Development Aid from people to People | Advocacy, Borehole Drilling, Capacity Building, Hygiene Education and Promotion and Renewable energy. | Luapula, Lusaka, Copperbelt, North Western, Southern | Morrice Muteba | morrice2001@yahoo.co.uk |
| World Vision | Advocacy, Borehole Drilling, Capacity Building, Sanitation, Hygiene Education and Promotion, IWRM and Renewable Energy. | Southern, Copperbelt, Northwestern Province , Lusaka, Northern, Eastern | Joyce Mweemba Sendoi | joyce_mweemba_sendoi@wvi.org |
| Plan Zambia | IEC, Borehole Drilling, Capacity Buiding | Eastern, Luapula, Muchinga | Wiscot Mwanza | Wiscot.mwanza@plan-interantional.org |
| Advocacy for Restoration and Enviroment in Zambia (AREZ) | IWRM, Capacity Building and Advocacy | Lusaka | Chozi Lungu | cvlungu@unza.zm |

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| Network for Environment and Solutions | Research livelihoods and Ecological Sanitation, Hygiene Promotion and Hygiene Education | Luapula, Lusaka, Copperbelt | Obed Kawanga | okawanga2001@yahoo.com |
| Village Water | Advocacy, water supply(Boreholes and wells), manual drilling, (jetting and rota sludge), capacity building, hygiene education, sanitation promotion, IEC, efficient energy utilisation, waste management. | Western , Copperbelt , Nothwestern. | Elisha Ng'onomo | elisha@villagewater.org |
| Water and Sanitation Association of Zambia | Advocacy,Borehole Drilling, Capacity Building, Hygiene Education, Hygiene Promotion, IEC, Renewable Energy, Sewerage Waste Water. | Southern, Copperbelt, Northwestern Province , Lusaka | Tuseko Sindano | tuseko@wasaza.org |
| Zambia WASHE Advocacy Network ( ZAWN) | Advocacy, Hygiene Education and Promotion | Eastern, Luapula, Lusaka | Bernard Miti | |
| Zambia Water and Sanitation Alliance | Advocacy, Hygiene Education and Promotion | Eastern, North Western, Lusaka | John Mushitu | dmushitu68@yahoo.com |
| Reformed Open Community Schools | Advocacy,Borehole Drilling, Capacity Building, Hygiene Education and Promotion | Lusaka, Eastern, Copperbelt, Northern | Marlon Phiri | marlonphiri@yahoo.com |
| Council of Churches in Zambia | Emergency Mitigation, Borehole Drilling, IEC, Hygiene Promotion. | central, Lusaka, North western, Southern, Western | George Chibwana | chibwanag@gmail.com |
| Peoples Processes on Houses and Poverty in Zambia | Advocacy, Borehole Drilling, Capacity Building, Hygiene Education, Hygiene Promotion, IEC, Sewerage and Waste Water. | Central, Copperbelt, North western, Lusaka, Eastern, Luapula, Northern, Southern | Margaret Lombe | mslombe@gmail.com |
| George Environmental Committee | Hygiene Education and Promotion | Lusaka | Chole Musonda | |

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| STOP UVE Community Health Society of Zambia | Hygiene Education and Promotion, Advocacy | Lusaka Southern | Benjamin Ndovi | |
| Youth Development Environmental Change Youth Development Environmental Change | Hygiene Education and Promotion | Central, Copperbelt | Julius Sakala | ydec@rocketmail.com |
| Kandodo Youth Development Memorial Theatre | Hygiene Education and Promotion | Eastern, Luapula, Lusaka, Southern | Gift Imbula | kmydt1991@yahoo.com |
| Forum For Youth Organisations in Zambia | Advocacy, Borehole Drilling | Central, Copperbelt, Eastern, Lusaka, Southern, Mongu | Andrew Tembo | andrewtembo2000@yahoo.co.uk |
| Youth Environment Network (YEN – Zambia) | Advocacy, Hygiene Education ,Promotion and Capacity Building | Copperbelt, Lusaka, Southern, Western | Evans Tembo | yenzambia@yahoo.com |
| VAREN -ZAMBIA | Advocacy, Capacity Building, Hygiene Education, Hygiene Promotion | Luapula | Mwenya Jackson | mwenyajack@yahoo.com |
| NESCOS | Hygiene Promotion and Capacity Building | Lusaka | Lloyd Siame | |
| COMWESO | Advocacy, Hygiene Education ,Promotion and Capacity Building | Lusaka | Paul Banda | paulbanda40@yahoo.com |

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Floodplains in Zambia: the Scope for Shallow Well Development

## Colofon

This note was prepared by Frank van Steenbergen, Matthijs Kool, Robert Vuik and Berry van den Pol and is part of the Tube Wells in Floodplains project.

The Tube Wells in Floodplains project, supported by Partners voor Water, aims to increase the productivity of marginally used floodplains by introducing a low-cost package of shallow tube well drilling techniques including pump technologies that can provide smallholder farmers with access to shallow groundwater.

The Spate Irrigation Network Foundation supports and promotes appropriate programmes and policies in spate irrigation, exchanges information on the improvement of livelihoods through a range of interventions, assists in educational development and supports in the implementation and start-up of projects in Spate irrigation. For more information: www.spate-irrigation.org.

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